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Cosmic Ray Balloon Expedition to India, IQSY-EQEX

National Center for Atmospheric Research

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XXXII. Cosmic Ray Balloon Expedition to India, IQSY-EQEX

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Since early 1963, the United States Committee for the International Quiet Sun Year (IQSY) of the National Academy of Sciences has studied the feasibility of sending a balloon expedition to the vicinity of the equator during this IQSY period, to conduct research in the field of cosmic radiation. The committee held several meetings with interested experimenters and found that there was strong interest in such an expedition.

Informal discussions were held with Professor M. G. K. Menon, Director of the Cosmic Ray Laboratory, Tata Institute of Fundamental Research, Bombay, about the possibility of organizing a joint expedition. His group also expressed strong interest in such a venture and official sanction for the expedition was obtained from the Indian IQSY Committee.

The program thus became a joint Indo-American IQSY activity. A proposal for funding the expedition was submitted to the National Science Foundation and has been approved. The authors, Robert Kubara, National Center for Atmospheric Research, and Bertram Stiller, U. S. Naval Research Laboratory, are serving, respectively, as Project Manager and Scientific Coordinator.

Approximately 16 flights will be flown, all of them being planned to reach at least 120,000 feet and to stay at floating altitude for at least 8 hours. Table 1 is a table summarizing the experiments and the conditions necessary for successfully carrying them out. Two important scientific reasons for making these flights in India are:

1. To obtain cosmic-ray data near the earth's geomagnetic equator at altitudes much higher than previously attained.
2. To obtain these data during IQSY so as to permit comparison with data obtained at other latitudes during the same part of the solar cycle.

In addition, due to the development of new measuring techniques such as spark chambers and solid-state detectors, it will be possible for the first time for cosmic-ray physicists to intercompare data obtained by a large variety of detecting systems. This possibility is of special interest when analyzing data obtained near the geomagnetic equator because the earth's magnetic field permits mainly galactic cosmic radiation to reach the detectors. Such data can be used to study astrophysical problems connected with the origin of cosmic rays and with stellar evolution.

Two major problems faced the expedition in addition to the usual ones connected with diplomatic clearances, logistics and funding.

First, the location in India and the time of year had to meet the general requirements of long floating times and need for recovery. Although wind conditions are fairly well known up to about 100,000 feet for Central India where long duration flights are possible, essentially nothing is known about wind conditions above 120,000 feet. On the basis of a thorough operational analysis by Mr. Samuel Solot of the National Center for Atmospheric Research, using available data, it was decided to plan launching the flights in the period March-April 1965. During a recent survey trip to India for site location, discussions were held with Indian meteorologists which led to the same conclusions. Additional discussions with members of the balloon group at the Tata Institute of Fundamental Research, who have successfully flown and recovered 60 cosmic-ray experiments in Central India during the last several years, further strengthened our decision. The primary launch site will be Hyderabad, but two secondary sites, one on the east and the other on the west coast, were also selected to allow for strong easterly or westerly winds at floating altitude. In order to make trajectory forecasts, sounding balloons carrying hypsometers will be launched daily and tracked by our GMD-1 unit. This program will commence about two weeks before the cosmic-ray flights in order to provide current information about the wind conditions above 120,000 feet.

Second, the occurrence of tropopause temperatures as low as -80°C at these latitudes in the Spring could further aggravate the already-difficult problem of tropopause penetration by polyethylene balloons.

Table 1. Cosmic Ray Balloon Expedition to India-1965, IQSY-EQEX

Experimenter	Type of Apparatus	No. of Flights	Weight (lb)	Altitude (thousand ft)	Duration (hr)	Recovery
K. A. Anderson Univ. of Calif.	γ + X-Ray Counters	3	40	130	≥ 8	Yes
J. G. Duthie U. Rochester	γ - Ray Spark Chamber	2 day night	250	>120	15	Yes
J. T. A. Ely AFCRL	Charged Particle Counter Telescope	2	90	140	≥ 10	Yes
M. F. Kaplon U. Rochester	Solid State Detector Telescope	2 day night	220	140	12	Yes
S. A. Korff New York Univ.	Neutron Counters	2	100	140	≥ 2	Yes
K. G. McCracken SWCAR-Dallas	Counter Telescope	2	100	120	≥ 8	Yes
M. M. Shapiro NRL	Nuclear Emulsions	2	100	140	≥ 12	Yes
C. J. Waddington U. Minnesota	Nuclear Emulsions	1	120	140	≥ 12	Yes
J. R. Winkler U. Minnesota	Ionization Chambers	Several Hitchhikes	10	Any	Any	Yes
M. G. K. Menon Tata Institute	Emulsion Chamber	1	2000	100	30	Yes
M. G. K. Menon Tata Institute	Nuclear Emulsions	Several Hitchhikes	5	Any	Any	Yes

The use of mylar-scrim balloons was contemplated until it was shown that this material was not yet capable of being used for successful flights of large balloons. The introduction of Stratofilm by Winzen Research, Inc., gave us the opportunity to conduct a series of trial flights for the purpose of comparing this material with the "normal" polyethylene being used by other balloon manufacturers. Four, 3-million-cubic-foot, taped, 3/4-mil Stratofilm balloons were purchased from Winzen, and four similar but tapeless balloons of "normal" polyethylene were purchased from Raven Industries. All eight balloons were launched during OPERATION COLDTROP from Panama where low tropopause temperatures were expected. The launchings were carried out by NCAR personnel with the enthusiastic support of an observer from Winzen Research whose cooperation is gratefully acknowledged. Table 2 tabulates the results of these eight flights. Balloons made of "normal" polyethylene burst in 3 out of 4 flights and successfully penetrated the tropopause only once. The two Stratofilm balloons which were launched went into floating altitude successfully. Unfortunately, constructional defects in the other two Stratofilm balloons, discovered during inflation, forced us to abort these flights. As a result the already-limited statistical validity of our test program was drastically reduced. Our decision to use balloons made of Stratofilm on this expedition is therefore based primarily on the long history of "normal" polyethylene balloon bursts at the tropopause, including the three at Panama, and only secondarily on the 100% ± 70% success rate of the two Stratofilm balloons in Panama.

The flight operations will be conducted by Raven Industries and the anchor-line launch technique will be used for all flights, with the exception of the 2000-pound payload for the Tata Institute. This will be launched dynamically, using a launch arm mounted on a truck. All flights will be tracked by an aircraft which will also direct surface vehicles to the area of impact for recovery of payloads. If weather and other conditions permit, one flight will be launched every other day, so that approximately five weeks will be needed for all of them. The authors will be in the field for the duration of the expedition and will serve in their respective capacities in order to insure that optimum conditions exist from the point of view of each scientific group before a balloon flight is attempted.

Although the motivation for this expedition came from the cosmic-ray community, it is within the scope of the expedition to make exposures for other scientists. Questions concerning such exposures should be sent to either of the authors.

Table 2. Project Coldtrop

Flight No.	Launch Date	Balloon Type	Balloon Weight (lb)	Gross Load (lb)	Free Lift (lb)	Ascent Rate (ft/min)	Flight Altitude (ft)	Remarks
1	8/5/64	Raven 3mm ft	456	781	88	1200	60,000	Balloon burst at 60,000 ft. Min. temp was -78°C @ 56,000 ft.
2	8/7/64	Winzen 2.94 NS	514	841.5	85	965	123,000	Successful flight. Trop. -76.3°C @ 53,000 ft.
3	8/8/64	Raven 3mm TT	444	767	61.5	930	126,000	Successful flight. Trop. -72.2°C @ 49,000 ft.
4	8/9/64	Winzen 2.94mm NS	520	845	68	885	123,000	Successful flight. Trop. -77.2°C @ 55,000 ft.
5	8/10/64	Raven 3mm TT	448.5	773.5	61.9	≈ 1000	51,000	Balloon burst at 51,000 ft. Temp. -71°C. Trop. -78°C @ 55,000 ft.
6	8/11/64	Winzen 2.94mm NS	566	891	80	0	0	Hole opened in balloon at top of 890 reinforcing tape 10 ft above inflation tube. 890 tape was attached directly to balloon without adequate reinforcement.
7	8/12/64	Winzen 2.94mm NS	559	884	79.5	0	0	Hole pulled in balloon at apex area starting at hoop and running out 18 in. Balloon not launched.
8	8/13/64	Raven 3mm TT	452	777	61.5	960	49,000	Balloon burst at 49,200 ft. Trop. was -75°C @ 49,000 ft.